MAR12-2011-000291

Abstract for an Invited Paper
for the MAR12 Meeting of
the American Physical Society

Large Area 3D Negative Index Metamaterials Formed by Printing

JOHN ROGERS, University of Illinois

Negative index metamaterials (NIMS) are man-made structures with values of permittivity and permeability that are simultaneously negative over some range of frequencies. Although advanced lithographic techniques can form the necessary three dimensional (3D) nanoscale features for NIMS, such methods can be applied only over small areas (100's of μm^2) on specialized substrates, with low throughput. This talk summarizes a 3D transfer printing method that can yield 3D-NIMs with excellent optical characteristics, in ways that are scalable to arbitrarily large areas and are compatible with manufacturing. We demonstrate 3D-NIMs with 11-layers and sub-micron unit cell dimensions, over areas > 75 cm^2, corresponding to $>10^5$x10^5 unit cells, all with excellent uniformity and minimal defects. These areas and numbers of unit cells both correspond to increases of more than 2x10^7 times, over previous results. Multiple cycles of printing with a single stamp demonstrate use in a manufacturing mode at throughputs that are $\sim 10^8$ times higher than those possible with state-of-the-art focused-ion beam lithography systems ($\sim$2.5 s per unit cell). Optical measurements show negative index of refraction in the NIR spectral range, with values as large as Re(n) $\sim$ -7 at $\lambda = 2.4$ μm and high figures of merit (FOM) of $\sim$8 at $\lambda = 1.95$ μm indicating low loss operation Related approaches can be used to form similar classes of 3D-NIMS with operation in the visible regime.